# Validity and Reliability of a 2D kinematics method for measuring athlete symmetry during the BMX gate start

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*DOI:*
10.13140/RG.2.2.33628.28806

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## INTRODUCTION

BMX Supercross (SX) racing technique has developed from the experiential knowledge of coaches and athletes. Quantitative analysis has been difficult due to the environment in which these races occur. Ecological validity in quantitative biomechanics has been has been shown to be important with field results differing from laboratory results in cycling activities [1].

This study quantifies the validity and intra-tester reliability of a 2D method for calculating sagittal plane kinematics during the BMX SX gate start action that utilises GoPro Hero® 4 Black 120 fps cameras and Kinovea software. This technique was used to analyze the symmetry of the sagittal kinematics of the upper body of elite BMX athletes.

## METHODS

All video data were collected during standard training sessions of the BMX Australia High Performance Unit and Development Academy. All athletes were aged 18-25 years and had competed in World Cup events in the 12 months prior to testing. A markerless motion capture technique was employed. Cameras were fixed to the start ramp as shown in Figure 1. Each camera was aligned so that the athlete start position was in the centre third of the frame and the start lights at the base of the ramp were visible. Ten participants each performed 5 maximum effort gate starts. The fastest trial for each participant was analyzed.

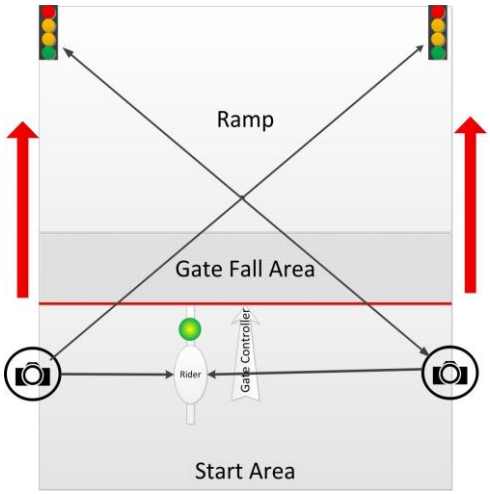


**Figure 1:** Top view of start ramp and gate with camera and rider.

Kinovea 0.8.15 (Kinovea.org, France) was used to track joint movement through the first 150 frames after the red start light activation. The trajectories were imported into Matlab 2014a (Mathworks, USA) where joint angles were calculated for ankle, knee, hip, shoulder, and elbow and segment angles calculated for the head, trunk and the crank.

To assess validity, the angle of a bike was measured off the track, then calculated using the same markerless motion capture technique. Intra-tester reliability for all measures was performed with 54.8 ± 30.8 (range: 28-106) days between repeated analysis of the same video files.

For two athletes (both at Olympic level), the symmetry between the right and left shoulder, elbow and trunk data were compared.

## RESULTS AND DISCUSSION

The method was shown to be valid to within 1.56 ± 0.92°. for all frames. The intra-tester reliability varied across the joints with the absolute error remaining less than 4.8 ± 0.5°. This was considered acceptable given the variation of movement between trials and between riders can be up to 50° (unpublished data) and in consideration of published literature [2, 3].

For both athletes, symmetry of the trunk and shoulder was within bounds of error. For one athlete, the elbow showed significant mean difference between left and right of 7.8 ± 1.1° ($p = 0.01$) across 5 trials. It is suggested that the movement of the torso from side to side of the centre of the bike for each pedal stroke is reflected in asymmetrical elbow angles. The asymmetry pattern observed would support this hypothesis.

## CONCLUSIONS

Go Pro Hero 4 Silver cameras can be used to analyse sagittal kinematics for the first ~1.2 s of the BMX gate start action. Upper body sagittal kinematics cannot be assumed to be symmetrical, even in top level athletes.

## ACKNOWLEDGEMENTS

The authors wish to acknowledge BMX Australia High Performance Unit Coach Wade Bootes and the BMX Australia High Performance Unit and Development Academy riders for their input and participation.

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